# EVALUATION OF MECHANICAL PROPERTIES OF ALUMINIUM ALLOY 7075 REINFORCED WITH SILICON CARBIDE AND RED MUD COMPOSITE

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**ABSTRACT**

Red mud is one of the major waste material during production of alumina from bauxite by the Bayer's process. It is an insoluble product generated after bauxite digestion with sodium hydroxide at elevated temperature and pressure is known as red mud or 'bauxite residue'. It comprises of oxides of iron, titanium, aluminium and silica along with some other minor constituents. Based on economics as well as environmental related issues, enormous efforts have been directed worldwide towards red mud management issues i.e. of utilization, storage and disposal. Different avenues of red mud utilization are more or less known but none of them have so far proved to be economically viable or commercially feasible. The red mud is classified as dangerous, according to NBR 10004/2004, and world while generation reached over 117 million tons/year. In present work experiments have been conducted under laboratory condition to assess the mechanical properties of the aluminium red mud and silicon carbide composite under different working conditions. This has been possible by fabricating the samples through stir casting technique. To enhance the mechanical properties, the samples were also subjected to heat treatment.

Key words**:** Al7075, Sic, Red mud, bauxite residue, composites, Stir casting, Mechanical properties,

## Introduction

History is often marked by the materials and technology that reflect human capability and understanding. Many times scales begins with the stone age, which led to the Bronze, Iron, Steel, Aluminium and Alloy ages as improvements in refining, smelting took place and science made all these possible to move towards finding more advance materials possible. Progress in the development of advanced composites from the days of E glass / Phenolic radome structures of the early 1940's to the graphite/ polymide composites used in the space shuttle orbiter-is spectacular.

The recognition of the potential weight savings that can be achieved by using the advanced composites, which in turn means reduced cost and greater efficiency, was responsible for this growth in the technology of reinforcements, matrices and fabrication of composites. If the first two decades saw the improvements in the fabrication method, systematic study of properties and fracture mechanics was at the focal point in the 60's. Since then there has been an ever-increasing demand for newer, stronger, stiffer and yet lighter-weight materials in fields such as aerospace, transportation, automobile and construction sectors.

Composite materials are emerging chiefly in response to unprecedented demands from technology due to rapidly advancing activities in aircrafts, aerospace and automotive industries. These materials have low specific gravity that makes their properties particularly superior in strength and modulus to many traditional engineering materials such as metals. As a result of intensive studies into the fundamental nature of materials and better understanding of their structure property relationship, it has become possible to develop new composite materials with improved physical and mechanical properties.

These new materials include high performance composites such as Polymer matrix composites, Ceramic matrix composites and Metal matrix composites etc. Continuous advancements have led to the use of composite materials in more and more diversified applications. The importance of composites as engineering materials is reflected by the fact that out of over 1600 engineering materials available in the market today more than 200 are composites.

## Experimental

### Materials

The problem is associated with the study of mechanical properties of Al- Red Mud and Silicon Carbide Metal Matrix Composite (MMC) of Aluminium alloy of grade 7075 with addition of varying weight percentage composition of Red Mud and Silicon Carbide particles by stir casting technique. The mechanical properties were tested under laboratory conditions. The change in physical and mechanical properties was taken in to consideration. For the achievement of the above, an experimental set up was prepared to facilitate the preparation of the required specimen. The aim of the experiment was to study the effect of variation of the percentage composition to predict the mechanical properties as well as to measure the micro hardness.

The experiment was carried out by preparing the samples of different percentage composition by stir casting technique. A brief analysis of microstructure had been conducted by Optical Microscope to verify the dispersion of reinforcement in the matrix.

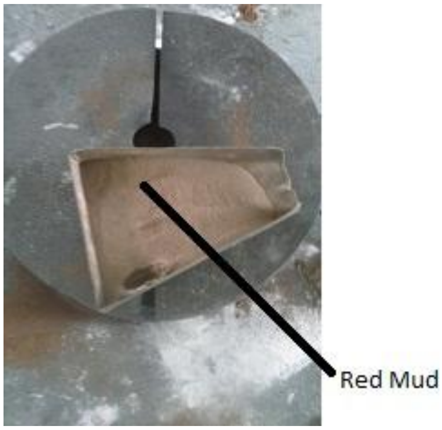



**Fig.1 Red Mud as Reinforcement** **Fig.2 Silicon Carbide (SiC) as Reinforcement**

## Test performed

The tests performed on different types of specimens are as follows:

- Tensile test
- Micro hardness test (BHN)
- Compression test
- Microstructure.

## Test Setup

### Tensile Test

The ultimate tensile strength was measured using 10 ton capacity servo hydraulic universal testing machine. The test specimen is in a direction parallel to the applied load. In a stress- strain graph the initial portion of the curve is a straight line and represents the proportionality of stress to strain according to Hooke's law. As the load is increased beyond which the stress is no longer proportional to strain.UTS is the maximum stress that a test specimen can bear before fracture and is based on original area.

**Fig.3- Specimens prepared for tensile testing**

All tests were conducted in accordance with ASTM standards. Tensile tests were conducted at room temperature using UTM in accordance with ASTM E8-82.The tensile specimens of diameter 8.9 mm and gauge length 76 mm were machined from the cast composites with the gauge length of the specimen parallel to the longitudinal axis of the castings. Five specimens were tested and the average values of the ultimate tensile strength (UTS) and Elongation were measured.

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Hardness Test

Brinell hardness test is also known as indentation hardness test where indentation hardness is defined as the resistant to permanent or plastic deformation under static or dynamic loads. The static indentation test was the type of test used in the present study to examine the hardness of the specimens in which a ball indenter was forced into the specimens being tested. The relationship of the total test force to the area or depth of indentation provides the measure of hardness.

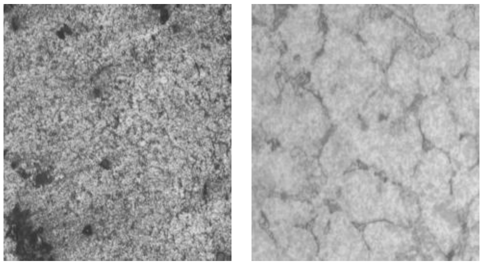
**Fig.4- Specimens for hardness test**

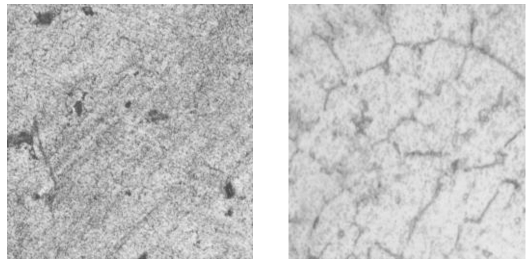
**Fig.5- Brinell hardness testing machine**

### Compression Test

Compression test was carried out using a standard 10-ton capacity universal testing machine as shown in Fig. 5.3. Compression tests were conducted on specimens of 20.21 mm diameter and 40 mm length machined from the cast composites, by gradually applied loads and corresponding strains were measured until failure of the specimen. The tests were conducted according to ASTM E9 at room temperature as shown in Fig. 6.

**Fig.6- Specimens for compression test**

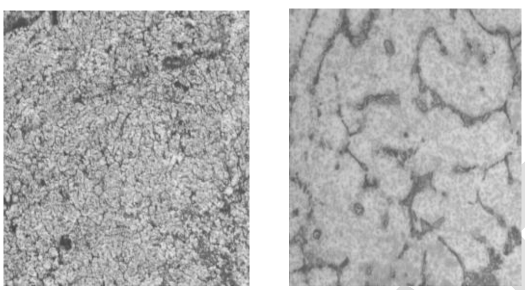


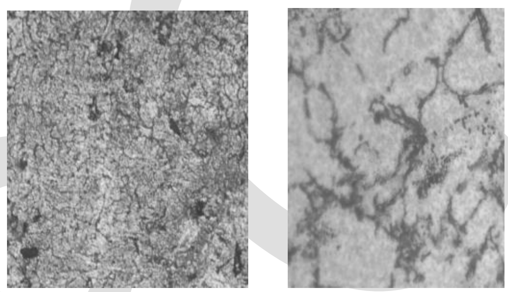


100X HF 500X HF 100X HF 500X HF

**Fig.7.1- Al 7075+8% Sic**

**Fig. 7.2- Al 7075+8% Red Mud**

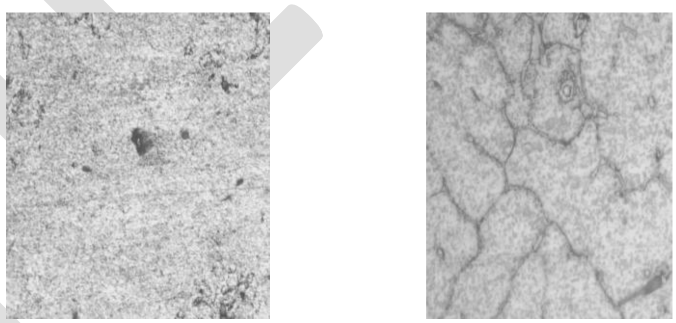




100X HF 500X HF 100X HF 500X HF

**Fig.7.3 Al 7075+SiC6%+Red Mud2%**

**Fig.7.4. Al7075+SiC4%+Red Mud4%**



100X HF 500X HF

**Fig.7.5 Al 7075+SiC2%+Red Mud6%**

**Results and Discussions**

Table 1. Mechanical properties of Al/ Red mud and SiC composite

| Varying Wt % Composition | UTS Mpa | Hardness BHN | Yield Strength Mpa | Compression strength Mpa | % Elongation |
|---|---|---|---|---|---|
| SiC8%+Al7075 | 65.65 | 107 | 56.0 | 44.71 | 1.32 |
| SiC6%+Red mud2%+Al7075 | 118.54 | 121 | 103.48 | 57.28 | 2.08 |
| SiC4%+Redmud 4%+Al7075 | 77.26 | 57.3 | 68.84 | 50.53 | 1.92 |
| SiC2%+Redmud 6%+Al7075 | 77.37 | 95 | 66.60 | 52.92 | 2.24 |
| Redmud 8%+Al7075 | 59.92 | 69 | 51.01 | 47.05 | 2.26 |

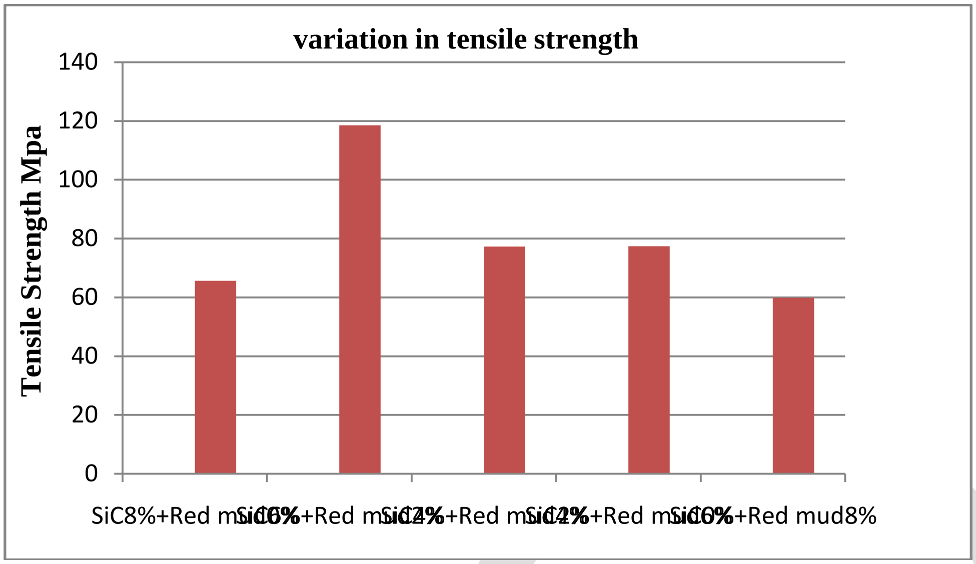



**Fig.8 graph shows variation in tensile strength from 0-8% of SiC and Red mud composite.**

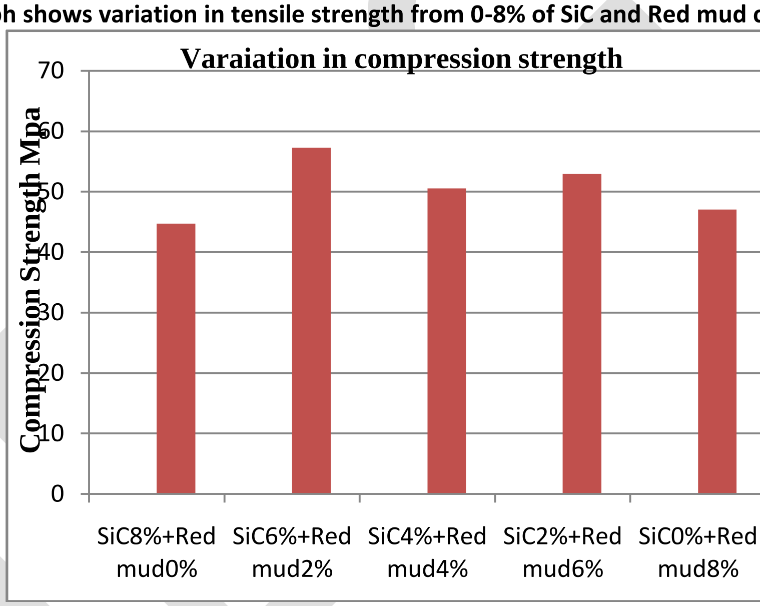



**Fig.8.1 graph shows variation in compression strength from 0-8% of SiC and Red mud composite.**

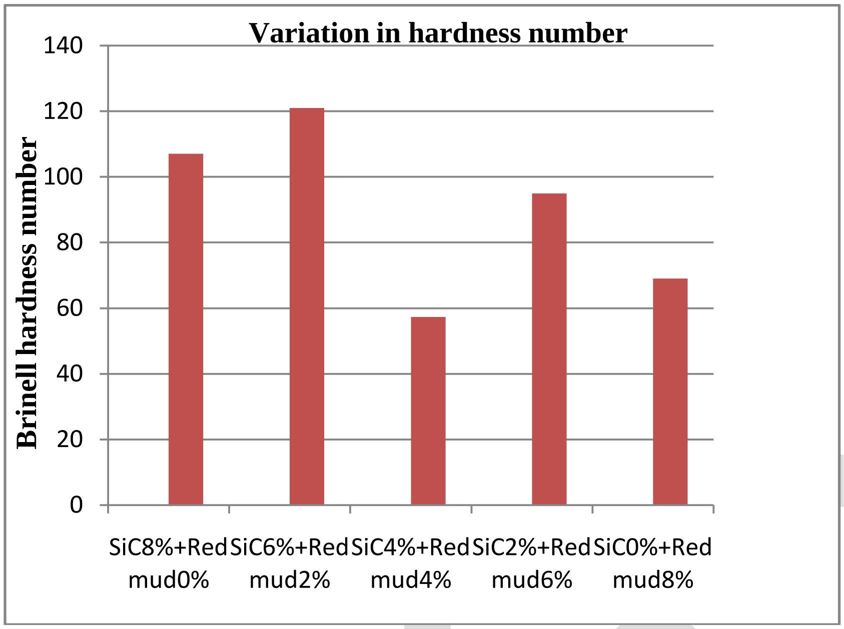



**Fig.8.2 graph shows variation in hardness number from 0-8% of SiC and Red mud composite.**

It has been observed that at SiC6%+Red Mud 2%+Al7075 there is considerable increase in almost all the mechanical properties.

## Conclusion

The general conclusion that is revealed from the present work is that by the combination of a matrix material with reinforcement such as SiC and Red mud particles, it improves mechanical properties like tensile strength, compressive strength, hardness and yield strength. Also microstructure studies indicate the presence of Aluminium dendrite structure with fine inter metallic particles SiC and Red mud reinforced in between.

## REFERENCES:

**[1]** k. Upadhya, "composite materials for aerospace applications, developments in ceramics and metal matrix composites", Kamaleshwar Upadhya, Ed.., warren dale,
PA: TMS publications, 1992, pp. 3-24.

**[2]** T.W. Clyne, An Introductory Overview of MMC System, Types and Developments, in Comprehensive Composite Materials, Vol-3; Metal Matrix Composites, T. W. Clyne (ed), Elsevier, 2000, pp.1-26.

**[3]** L.M.Manocha & A.R. Bunsell "Advances in composite materials", Pergamon Press, Oxford, 1980, Vol.2, p 1233-1240.

**[4]** R.S.Thakur & S.N.Das; "Red mud Analysis & Utilization", published by NISCOM and Wiley Eastern Ltd., New Delhi, 1994.